April 12, 1966 H. J. SCAGNELLI 3,246,280

MICROCIRCUIT CONNECTOR

Original Filed Nov. 23, 1962 2 Sheets-Sheet 1

FIG. 1A
PRIOR ART

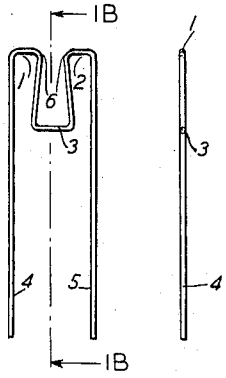


FIG. 1B
PRIOR ART

FIG. 2C

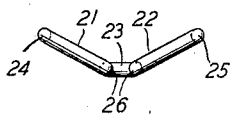


FIG. 2A

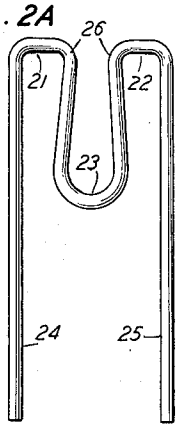


FIG. 2B

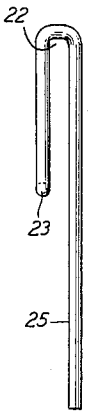


FIG. 3C

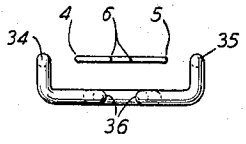


FIG. 3A

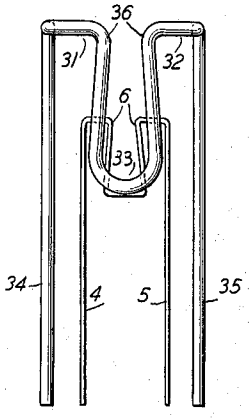


FIG. 3B

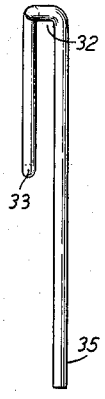


FIG. 4A

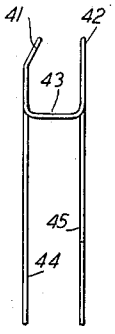
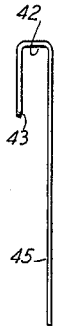


FIG. 4B



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April 12, 1966 H. J. SCAGNELLI 3,246,280

MICROCIRCUIT CONNECTOR

Original Filed Nov. 23, 1962 2 Sheets-Sheet 2

FIG. 5

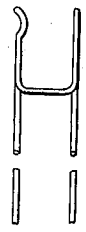


FIG. 6

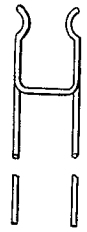


FIG. 7

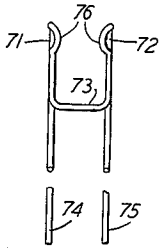


FIG. 8

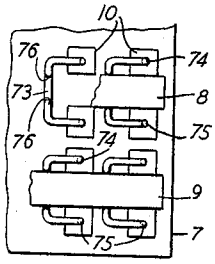


FIG. 9

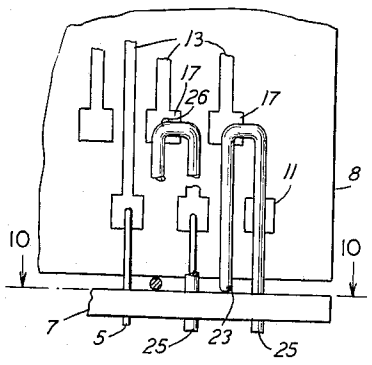
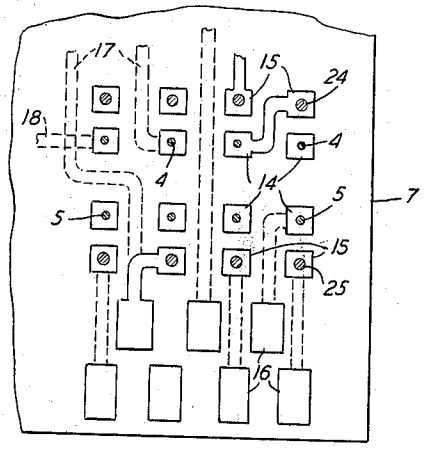


FIG. 10



United States Patent Office 3,246,280 Patented Apr. 12, 1966

3,246,280

MICROCIRCUIT CONNECTOR

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Continuation of application Ser. No. 239,837, Nov. 23, 1962. This application Mar. 9, 1965, Ser. No. 446,764
5 Claims. (Cl. 339—17)

This invention, which is a continuation of the copending application Serial No. 239,837, filed November 23, 1962, now abandoned, relates to microcircuit connectors and more particularly to a connector for assembling printed circuit boards used in microcircuitry.

Considerable effort has been expended during recent years to both reduce the size and the cost of complex electronic circuits without in any way reducing their reliability and usefulness. A problem common to all such efforts is that of maintaining reliability. Oftentimes the solution to a problem of size reduction is solved by changing the shapes of the component parts and such solutions frequently take on the aspects of an elusive puzzle. The shape of the part must not only result in a greater circuit density but it also must not disproportionately increase the cost of the product by reason of difficulty in its fabrication. One of the principal problems involved in microcircuitry has been the problem of interconnecting printed circuit boards in the form of modular packages since a large number of connections between the boards frequently have to be made. A satisfactory solution to this problem has not been achieved in the past and this has been a major obstacle to the realization of the full potential offered by multilayer printed circuits. Multilayer printed circuits permit very compact construction on a single board but lack of adequate access to these boards for connections between several of them has defeated many attempts to take full advantage of multilayer printed circuits in constructing high density modular packages. It is quite essential that the connecting device employed meets the combined requirements of low cost, compactness and reliability. Since a microcircuit modular package generally comprises a great many component parts, it necessarily follows that a failure in a connector unit which requires disassembly of a major portion of the package for repair can become quite costly so that the factor of reliability becomes of prime importance.

It is an object of this invention to increase the density of printed circuit packages without loss of reliability thereby reducing the space required for electronic circuitry.

The foregoing object is achieved by this invention which comprises a connector for assembling printed circuit boards to a printed wiring board. The connector comprises two rows of terminal lands on the circuit board which extend parallel to and near one edge thereof. Connector elements, secured to terminal lands on the wiring board, engage both rows of terminal lands on the circuit board. Each of the connector elements in one of these rows comprises a length of wire, or other rod of conductive material, bent generally in the shape of the letter "U," its legs being adapted for insertion in holes through the terminal lands on the wiring board. A portion of each leg near the bend is further bent until the first bend faces in the reverse direction and lies in a plane outside that established by the legs. This construction permits staggering the terminal lands of one of the rows on the printed circuit board with reference to those in the other row, thereby doubling the number of access terminals without any significant increase in board size.

The invention may be better understood by reference to the accompanying drawings, in which:

FIGS. 1A and 1B represent a typical terminal clip of the prior art;

FIGS. 2A, 2B and 2C show front, side and top views, respectively, of one embodiment of the invention suitable for doubling the number of interconnections between a printed circuit board and its wiring board;

FIGS. 3A, 3B and 3C show front, side and top views, respectively, of a further embodiment of the invention as used in combination with a clip of the prior art for doubling the number of connections;

FIGS. 4A, 4B, 5, 6 and 7 show various embodiments of the invention suitable for increasing the number of printed circuit boards which may be connected to a given wiring board;

FIG. 8 illustrates the use of the embodiment shown in FIG. 7 with fragmentary showings of two printed circuit boards connected to their wiring board;

FIG. 9 is an elevation view illustrating the manner in which the connectors of FIGS. 1A, 2A and 3A may be used; and

FIG. 10 is a plan view taken on line 10—10 of FIG. 9 showing how the connectors are inserted in the printed wiring board.

FIGS. 1A and 1B are greatly enlarged front and sectional side views of a typical connector clip of the prior art. This clip is usually made of beryllium copper wire which may have a diameter as small as about 10 mils. It will be noted that this clip is formed of three bends, 1, 2 and 3, having legs 4 and 5 which are substantially coplanar. FIG. 1B is taken on line 1B—1B of FIG. 1A to illustrate the fact that the legs of bend 3 are coplanar with legs 4 and 5. In use, the legs 4 and 5 are passed through holes in a wiring board having conductive lands to which they may be soldered. The lower surface of bend 3 is generally brought down flush with the surface of the wiring board and the printed circuit board is inserted in bend 3 so that one or both of the bends 6 may engage connection terminals on the printed circuit board. It will be recognized that the simplicity and small size of this device contributes very much toward reduction in the size of circuit packages.

Notwithstanding the small size of the connector of FIG. 1A, the number of such connectors that may be placed along the length of a printed circuit board is limited by the size of the terminal lands on the printed circuit board with which these connectors will engage. These terminal lands must be of sufficient size to make reliable conditions to the clips and at the same time provide adequate insulation space between them to insure not only reliability from the standpoint of insulation between the original lands, but also to be sure that they will not be bridged in the soldering operation. A similar problem also exists on the wiring board through which legs 4 and 5 are to pass. In this latter case, however, the spacing must be further increased between the terminal lands to provide space for the printed circuit wiring.

The three views of the embodiment of this invention shown in FIGS. 2A, 2B and 2C are illustrative of a clip which, when combined with a clip of the type shown in FIG. 1A, enables one to double the number of interconnections between the printed circuit board and its wiring board without encroaching on the space neded for insulation, for solder and for the printed circuit conductors in the wiring board. It will be noted that this connector has a central bend 23 defining a plane which lies out of the plane defined by its legs 24 and 25. This is especially noticeable in the top view which shows bend 23 lying in a plane displaced from that established by the legs 24 and 25. It will also be noted that bend 23 defines a plane which forms an angle with the two planes formed by the additional bends 21 and 22, respectively,

and that these latter two planes each form dihedral angles with the plane of bend 23, which angles are each less than a straight angle. In this way the construction of the clip in FIG. 2A differs from that of FIG. 1A. With such a construction, the bent portions 26 may engage printed circuit terminal lands which are displaced from any which may be aligned with legs 24 and 25. To further facilitate proper elastic contact with the terminal lands, the portions 26 of the additional bends 21 and 22 are slightly bent toward each other as illustrated in the front view of FIG. 2A. The space between legs 24 and 25 is greater than the space needed for bend 23 and is sufficient to include the clip of FIG. 1A so that all four legs of the two clips may be placed in alignment on a wiring board. This is illustrated for the further embodiment disclosed in FIGS. 3A, 3B and 3C. Bend 23 is deeper than bend 3 of FIG. 1A so that bent portions 26 can reach farther inside the border of a circuit board to engage additional terminal lands as will be described later. The advantages of forming the clip in this manner will become more apparent as the description proceeds.

The embodiment shown in FIG. 3A differs from that shown in FIG. 2A in that loops 31 and 32 are each formed by three bends of substantially 90 degrees. This will become readily apparent by comparing the three views of FIGS. 3A, 3B and 3C with those of FIGS. 2A, 2B and 2C. There is no special advantage in the construction of FIG. 3A over that of FIG. 2A and for fabrication reasons the FIG. 2A construction is slightly simpler and is generally preferred. The front and top views of FIGS. 3A and 3C illustrate the relative positions of the clip of FIG. 1A in combination with the clip of this invention. It will be noted that the legs 34 and 35 are in line with legs 4 and 5 so that space on a wiring board between adjacent groups of these clips may be preserved for printed wiring. As will be described later, no additional space along the length of the wiring board is needed in order to accommodate this clip arrangement.

The clips of FIGS. 4A, 4B, 5, 6 and 7 are similar to the clip of FIG. 2A except that the dihedral angles previously described are made substantially 90 degrees. These clips are especially valuable in increasing the number of printed circuit boards that may be connected to a given printed wiring board and their use can effectively transfer the restriction on space between adjacent printed circuit boards from those imposed by the terminal clips to those imposed by the components on the boards. These clips, therefore, provide for maximum package density limited only by the components applied to the printed circuit boards and the thickness of those boards.

The particular embodiment shown in FIG. 4A shows only one of the upper bends 41 turned inwardly to make the connection with the terminal land on the circuit board. It will be understood that the circuit board is to be inserted between bends 41 and 42 so that bend 41 engages the terminal land on the board. To facilitate easy entry of the board between these bends, the upper end of bend 41 may be arced concave outwardly as illustrated in FIG. 5 or both loops may be similarly bent as shown in FIG. 6.

The modification shown in FIG. 7 comprises forming the bends to engage the terminal lands on the circuit board only on the upper portions of the central bend 73, the upper portions of legs 74 and 75 remaining straight until they reach bends 71 and 72. No side views are shown for FIGS. 5, 6 and 7. However, their side views would be essentially identical to that shown in FIG. 4B.

FIG. 8 illustrates the manner in which the clips of FIGS. 4A, 5, 6 and 7 may be employed in connecting the circuit boards to a wiring board. In this case, fragmentary portions of two circuit boards 8 and 9 are shown connected to a printed wiring board 7 by way of connectors of the type shown in FIG. 7. The printed wiring board 7 contains a plurality of conventional terminal lands 10 having holes in their centers through which the legs of the terminal clips are passed and subsequently soldered. The lower end of bend 73 is, in accordance with conventional practice, resting on the upper surface of wiring board 7 and the circuit boards 8 and 9 are inserted until their lower edges rest against or close to the inside of the bend 73 of each terminal clip. To more clearly show the installation of one of these clips, circuit board 8 has been cut away from the upper left clip in FIG. 8. It will be understood that the printed circuit boards 8 and 9 have printed circuit lands on either or both sides thereof and in alignment with the bent portions 76 of the clips. These may be subsequently soldered after completing preliminary electrical tests.

Since legs 74 and 75 of these clips have been brought together to a minimal distance, it will be evident that the circuit boards 8 and 9 can be brought much closer together than is possible with a clip of the type shown in FIG. 1A, thereby very materially increasing the circuit density of the package.

FIG. 9 shows an assembly of the clips of FIG. 1A combined with those of this invention as disclosed in FIGS. 2A and 3A. For example, it may be assumed that the embodiment shown in FIG. 2A is being used. In this case, legs 24 and 25 are brought through the wiring board 7 in alignment with their co-operating terminal clip of FIG. 1A. One row of terminal lands 11 on the circuit board 8 is provided for the clips of FIG. 1A while a second row of terminal lands 17, parallel to the first row, is provided for the clips of FIG. 2A so that their bent portions 26 may engage the lands in row 17. Since the legs 24, 25 are in line with legs 4 and 5, they do not encroach on the space required for the interconnecting circuits in the wiring board 7. It is to be understood that wiring board 7 is of the conventional multilayer type in which all of the circuits may be between layers. In this way, the lower part of the bends 23 may rest directly on the upper surface of wiring board 7. It will also be evident from FIG. 9, that ample space is available between the upper row of terminal lands 17 for those printed circuit paths 13 which extend to the lower row of terminal lands 11. Since bent portions 3 and 23 of the two clips must not touch each other when assembled to the wiring board 7, provision must be made to avoid this contact. This is achieved by two distinctive features of this invention. First, the terminal lands 11 and 17 are arranged staggered or offset on the circuit board 8 so that vertical center lines through lands 11 lie between lines parallel to them and passing through the centers of lands 17. Second, the terminal clips connecting to the upper row of lands 17 are each formed with its parallel leg portions 24, 25 in a different plane than that defined by the leg portions between the first bend 23 and bent portion 26. An outstanding advantage of these features is that they permit twice the number of terminal connections to be made between the two boards without increasing their lengths.

A view of the circuit board 7 taken on line 10—10 of FIG. 9 is shown in FIG. 10 to show the manner of connecting the connector clips to the circuits in the wiring board 7. It will be noted that one pair of rows of terminal lands 14 are adapted to receive the legs 4 and 5 of the terminal clips of FIG. 1A while a second pair of rows of terminal lands 15 are adapted to receive the legs 24 and 25 of terminal clips such as shown in FIG. 2A. The connections from these terminal lands may be arranged to meet any circuit requirements not only for their interconnection but also for their connections to two rows of terminal lands 16 which comprise a plug for connecting the wiring board to external circuitry through a printed circuit socket, not shown, or to another terminal arrangement similar to FIG. 9. The various circuit paths 17 are shown dotted to illustrate their positions between the laminations comprising the wiring board 7. It will be understood that, at such cross-overs as the one shown at

18, the two circuit paths are separated by an insulating layer forming part of the wiring board. As shown in this figure, legs 4 and 5 are in line with their companion legs 24 and 25 so as not to encroach on the space between this set of four terminal lands and those for the next pair of circuit clips to their left, thereby leaving adequate space between them for the required circuit connections. It will be appreciated that if an attempt is made to increase the number of connections between the circuit boards by increasing the number of terminal lands in a single row, such as, for example, row 14, insufficient space would exist between them for the necessary connections. This limiting factor is eliminated by using the connectors shown in FIGS. 2A and 3A.

As previously described, the connector clips shown in FIGS. 2A and 3A permit doubling the number of connections between the circuit board and its wiring board without increasing the length of the circuit board. This advantage is clearly illustrated in FIGS. 9 and 10. Also the terminal clips shown in FIGS. 4A through 7 permit materially increasing the number of circuit boards which may be connected to a given wiring board as illustrated in FIG. 8.

Although the invention, as disclosed, suggests a rod of beryllium copper wire having a circular cross section, it is obvious that any other conductive material having a different shape may be substituted, the choice of material and shape depending on particular end use requirements to be met.

While this invention has been disclosed with reference to particular embodiments thereof for illustrative purposes it will be evident to those skilled in the art that various modifications may be made employing the principles of the invention without departing from its scope.

What is claimed is:

1. A microcircuit connector for connecting printed circuit boards to a wiring board, said connector comprising two rows of terminal lands on the surface of said circuit board and arranged substantially parallel to and near an edge thereof, the lands in one row being positioned so that lines passing through their centers and perpendicular to said edge lie between parallel lines passing through the centers of the lands in the other row, a plurality of terminal lands also on said wiring board, means connecting some of the wiring board lands to the lands in one of the rows of said circuit board, and other means connecting other wiring board lands to the lands in the other row of said circuit board, said other means comprising a rod of conductive material having two ends, a bend in said rod intermediate its ends to form two legs and to substantially define a plane, said two legs each having at least one additional bend to bring those portions of the two legs between said ends and said additional bends substantially parallel to each other and outside said plane, the portions of said additional bends which lie in the region of said plane having a space between them less than the distance between any two other corresponding parts of the two legs.

2. A microcircuit connector for connecting printed circuit boards to a wiring board, said connector comprising two rows of terminal lands on the surface of said circuit board and arranged substantially parallel to and near an edge thereof, the lands in one row being positioned so that lines passing through their centers and perpendicular to said edge lie between parallel lines passing through the centers of the lands in the other row, a plurality of terminal lands also on said wiring board, means connecting some of the wiring board lands to the lands in one of the rows on said circuit board, and other means connecting other wiring board lands to the lands in the other row of said circuit board, said other means comprising a rod of conductive material having two ends, a bend in said rod intermediate its ends to form two legs and to substantially define a plane, said two legs each having an additional bend extending through a sufficient angle to bring those portions of the two legs between said ends and the said additional bends substantially parallel to each other outside said plane and separated from each other a distance substantially greater than the distance between the portions of said rod forming said first named bend.

3. A microcircuit connector for connecting printed circuit boards to a wiring board, said connector comprising two rows of terminal lands on the surface of said circuit board and arranged substantially parallel to and near an edge thereof, the lands in one row being positioned so that lines passing through their centers and perpendicular to said edge lie between parallel lines passing through the centers of the lands in the other row, a plurality of terminal lands also on said wiring board, means connecting some of the wiring board lands to the lands in one of the rows on said circuit board, and other means connecting other wiring board lands to the lands in the other row of said circuit board, said other means comprising a rod of conductive material having a first bend conforming generally to the shape of the letter U so as to have two legs substantially defining a first plane, said legs each having an additional bend to define second and third planes which form with said first plane dihedral angles less than a straight angle but not less than a right angle, the outer extremities of said rod being formed substantially parallel to each other, the portions of said additional bends which lie in the region of said first plane having a space between them less than the distance between any two other corresponding parts of the two legs.

4. The combination of claim 1 wherein the portions of the two legs between said ends and said additional bends are separated from each other a distance substantially greater than the distance between the portions of said rod forming said first named bend.

5. The combination of claim 2 wherein those portions of said additional bends which lie in the region of said plane are separated by a distance substantially less than the distance between any two other corresponding parts of the two legs.

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